1.3 MODEL CHARACTERISTICS

The SFWMM is a regional-scale hydrologic model that simulates physical processes in the natural (coupled surface water and ground water) and man-made (canals, structures and reservoirs) systems in South Florida. It includes management and operational rules established, mostly by the Corps, for operating the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project). As a planning tool, the model can be used to predict the response of the hydrologic system to proposed changes in hydraulic infrastructure and/or operating rules. The design of the model takes into consideration the distinct hydrologic and geologic features of subtropical South Florida which includes: 1) the strong interaction between canals and the highly permeable surficial aquifer, especially in the eastern portion of the region; and 2) the dominance of evapotranspiration, and overland flow and groundwater movement within the Water Conservation Areas (WCAs) and Everglades National Park (ENP). To jointly simulate these complex processes, a distributed parameter/cell-based network is used. The SFWMM integrates hydrologic processes with the hydraulic infrastructure and associated policy-based rules and guidelines related to water management in South Florida.

Figure 1.3.1(a) shows the model boundary relative to South Florida. Geographically, the model can be divided into three different areas. Each area is conceptualized at a different level of detail. The necessity to break the model into these areas is primarily due to varying data availability which, in turn, requires different computation methods. The SFWMM employs both lumped and distributed modeling techniques.

The gridded portion of the model domain describes the extent of the finite difference solution to the governing overland and groundwater flow equations and is defined just south of Lake Okeechobee [Fig. 1.3.1(b)]. The network is comprised of 2-mile square grid cells that cover the large coastal urban areas of Palm Beach, Broward and Dade counties; Everglades Agricultural Area (EAA); the Water Conservation Areas and Everglades National Park. The total coverage of the model is 1,746 grid cells. The model assumes homogeneity in physical as well as hydrologic characteristics within each grid cell. With this assumption, a grid cell may also be referred to as a nodal point or simply, a node. In addition to water levels at grid cells, and surface and groundwater flow between cells, the model also calculates discharges for the major hydraulic structures within the model grid.

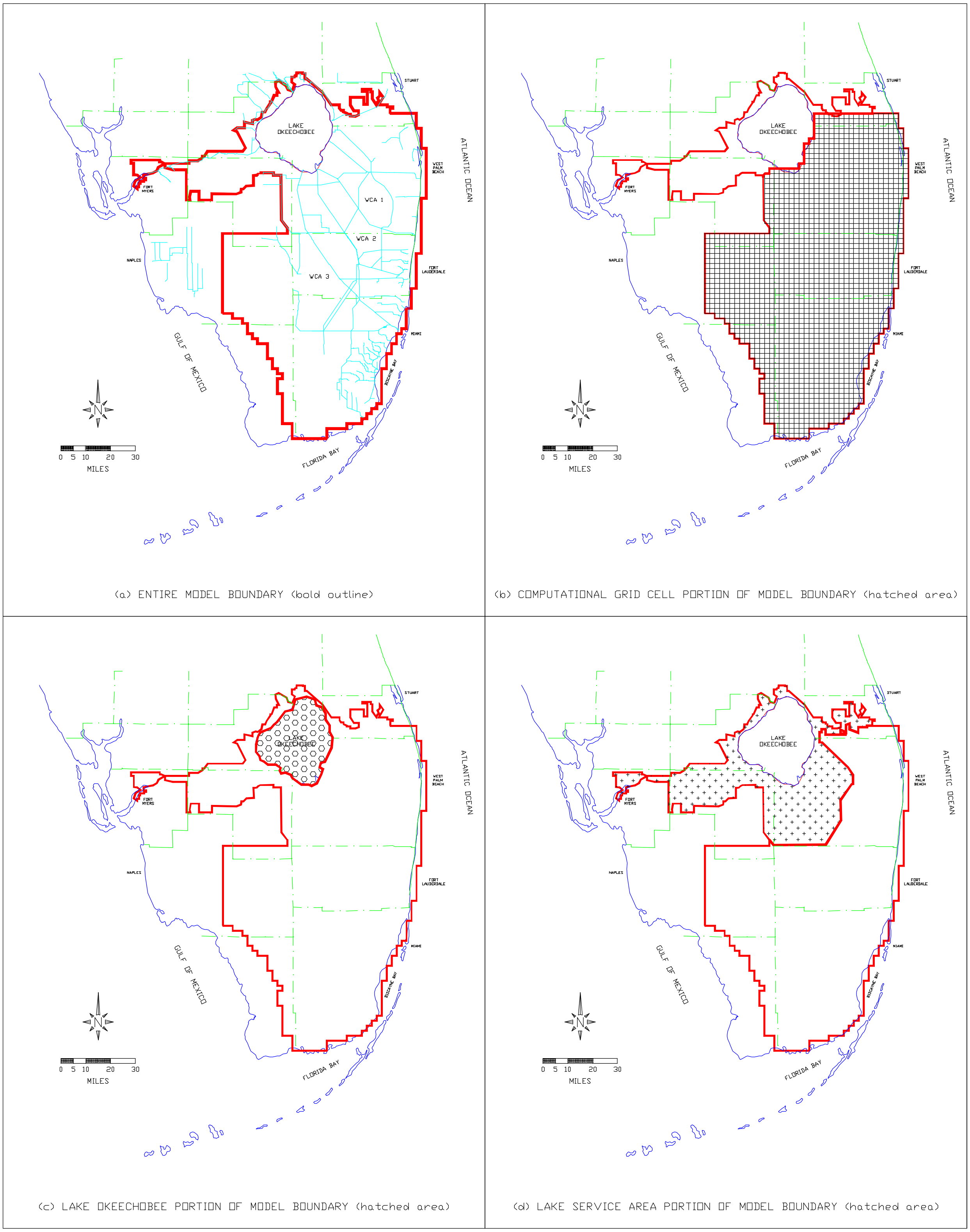
Lake Okeechobee is modeled as a lumped system, or regarded as a single point in space without dimensions where simulated water levels and/or flow rates are spatially averaged [Fig. 1.3.1(c)]. The amount, timing and distribution of structure flows in and out of the lake are dictated by management rules related to flood control, water supply, and environmental restoration. One might note that some of these rules, e.g. regulation schedules and supply-side management, are actually in operation but a few more are incorporated in the model to address proposed operating policies, specifically those related to the Everglades environmental restoration.

Finally, a simple flow balance procedure is used for the rest of the Lake Okeechobee service areas except in the EAA where assumed demand and runoff characteristics are combined with appropriate lake operational rules to calculate flow distribution from within [Fig. 1.3.1(d)]. Other hydrologic characteristics such as water levels, rainfall and evapotranspiration amounts, and overland and groundwater flow are not simulated in this portion of the Lake Okeechobee Service Area (LOSA). They are assumed to be consistent with the user-input time series of demand and runoff quantities which are otherwise calculated in the gridded portion of the model domain.

A fixed time step of one day is used in the model. The selection of this time step is consistent with the minimum time increment for which hydrologic data such as rainfall, evaporation and structure discharge are generally available. Rainfall and potential evaporation (PET) are the primary driving processes. Therefore, the longest total simulation time for the model is a function of the available historical (or an estimate of historical) rainfall and PET data. The model can be run for as short as one month and for as long as 31 years from January 1, 1965 through December 31, 1995 (version 3.2 and later). The hydrologic processes are generally modeled sequentially within one time step. A continuous unconfined groundwater system (without perched conditions) is assumed to underlie the gridded portion of the model domain. To simplify programming and reduce computational time, no iteration is performed between surface and ground water routines within a time step. Calculations for more transient phenomena, such as channel flow routing, are performed before less transient phenomena, such as groundwater flow. The bulk of the computer code, on the other hand, is comprised of the operational rules that drive the human management of the entire system. The close relationship between the natural hydrology and hydraulic infrastructure in South Florida makes the SFWMM unique.

Data required to describe the physical features of the modeling domain such as land elevation and land use types are readily available from the District's GIS database. Many physical parameters such as seepage rate factors, overland flow roughness coefficients and aquifer transmissivity were estimated within reasonable ranges. A calibration of the model was recently performed to ascertain the values of these parameters. In general, the purpose of this effort was to verify and/or improve the predictive capability of the model by: (1) incorporating the best available data; (2) introducing new/improved algorithms into the model; and (3) adjusting calibration parameters to obtain a close agreement between model output and historical flow and/or stage data. Included in this report is a representative sample of calibration results in different areas within the system.

Sun™ FORTRAN 1.4 (or later) is the programming language used in coding SFWMM. The current model is comprised of 27,000 lines of executable code grouped into 61 subroutines and functions. The model can be run on a Sun Sparcstation™ under the SunOS™ 4.1.3 (or later) operating system. Flat: text or ASCII format; binary: Grid_io (Van Zee, 1993); and HECDSS (USACE, 1994) formats are used on both input and output. Total execution time varies according to CPU speed, network traffic and scenario being simulated; the model generally takes between 5 to 20 minutes of computer time for each year of simulation on a Sun SPARCstation 20.



(a) ENTIRE MODEL BOUNDARY (bold outline)

(b) COMPUTATIONAL GRID CELL PORTION OF MODEL BOUNDARY (hatched area)

(c) LAKE OKEECHOBEE PORTION OF MODEL BOUNDARY (hatched area)

(d) LAKE SERVICE AREA PORTION OF MODEL BOUNDARY (hatched area)

Figure 1.3.1 South Florida Water Management Model Boundaries

The general hydrologic processes simulated by the SFWMM are depicted in Fig. 1.3.2. The loss of water to the atmosphere by evapotranspiration is considered by the model to occur from above and below the land surface. This distinction makes it possible to do a water budget for the entire layer of the soil column as well as the saturated and unsaturated zones that comprise the subsurface region of the model. Overland flow can be partitioned into a cell-to-cell transport of surface water (sheetflow) and movement of surface water directly into a receiving canal (drainage). Other processes such as seepage across levees, and leakance/seepage into and out of canals fall under the general category of groundwater flow and is discussed in more detail in the following sections. Finally, canal flow describes the passage of water from one water body, typically a canal reach, across a hydraulic structure into another water body such as a downstream canal reach, reservoir or detention facility.

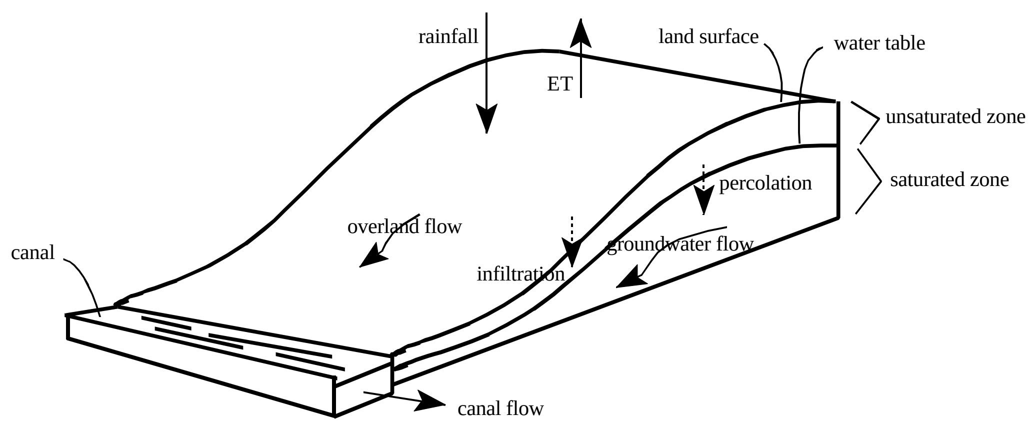


Figure 1.3.2 General Hydrologic Processes in the South Florida Water Management Model

The degree of complexity increases as one superimposes the hydraulic structures and corresponding operational rules to the system. Thus, Fig. 1.3.2 only shows the natural hydrology simulated in the model. The operational and management component is more complex and the discussion of the corresponding processes will be made with respect to the areas where they apply, e.g., Supply-Side Management for Lake Okeechobee, STAs for EAA, et al. Figure 1.3.3 is a simplified flowchart of the overall organization of the model. A brief description of the subroutines and functions used in the model is given in Chap. 4.

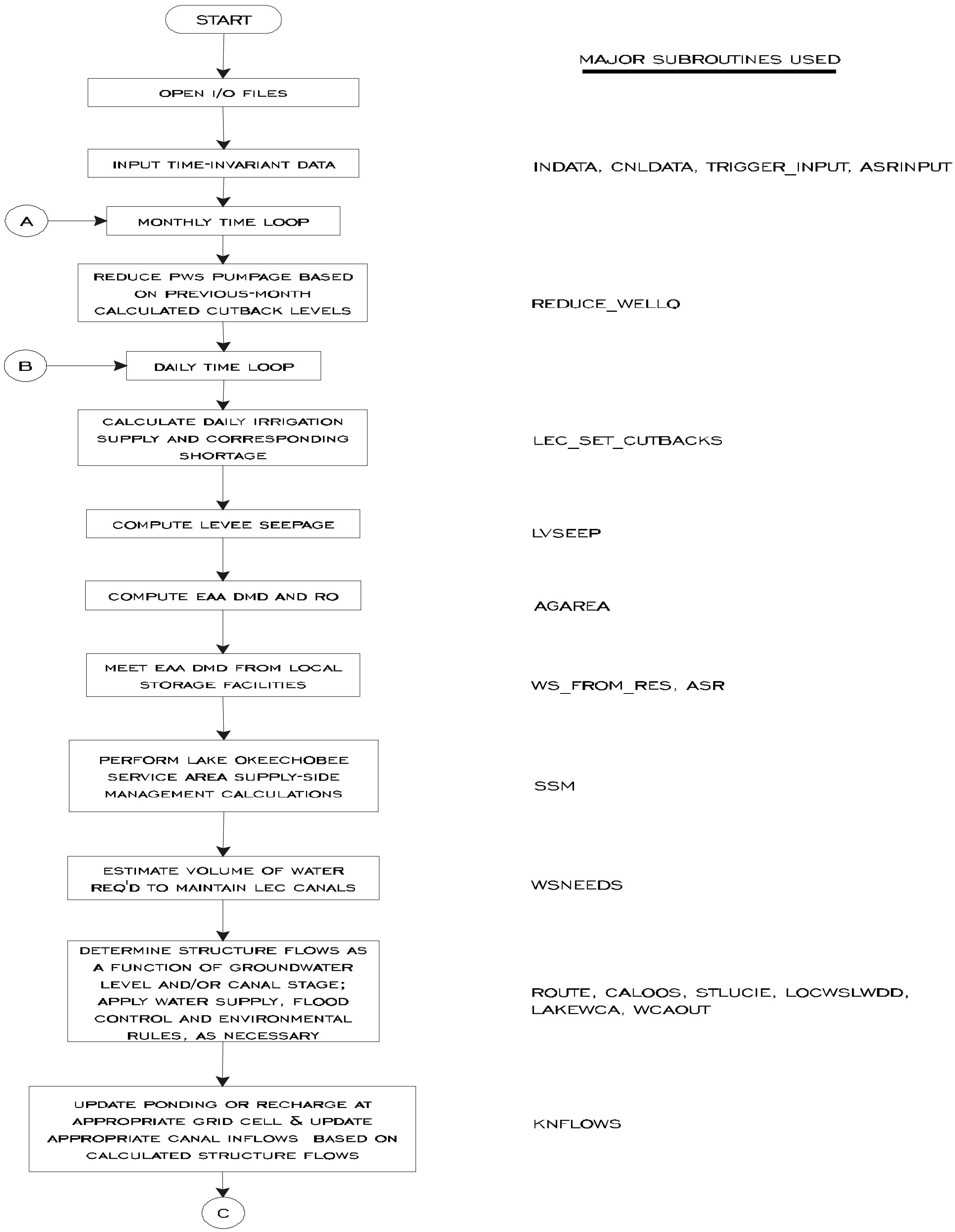


Figure 1.3.3 Simplified Flowchart for the South Florida Water Management Model

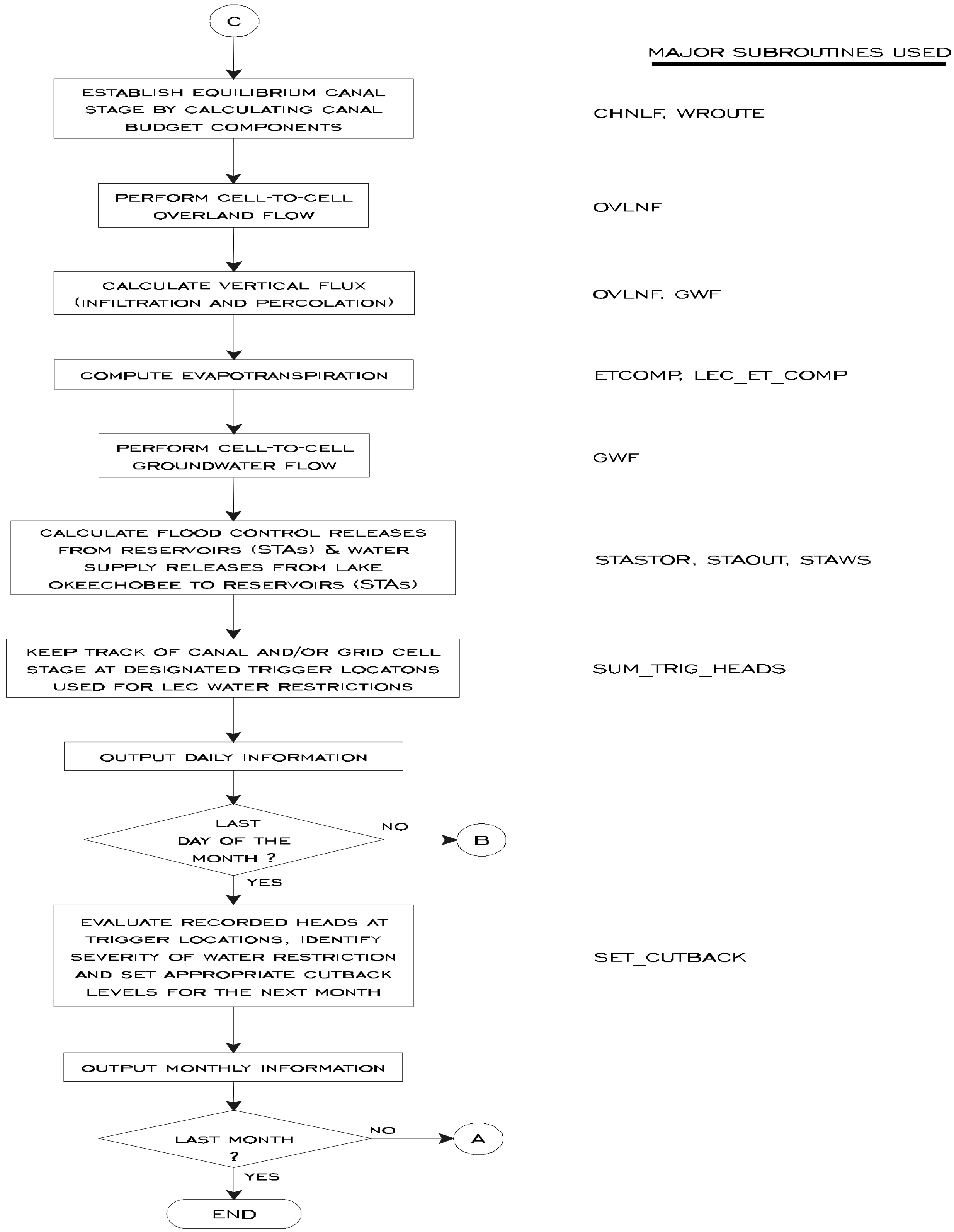


Figure 1.3.3 (*cont.*) Simplified Flowchart for the South Florida Water Management Model

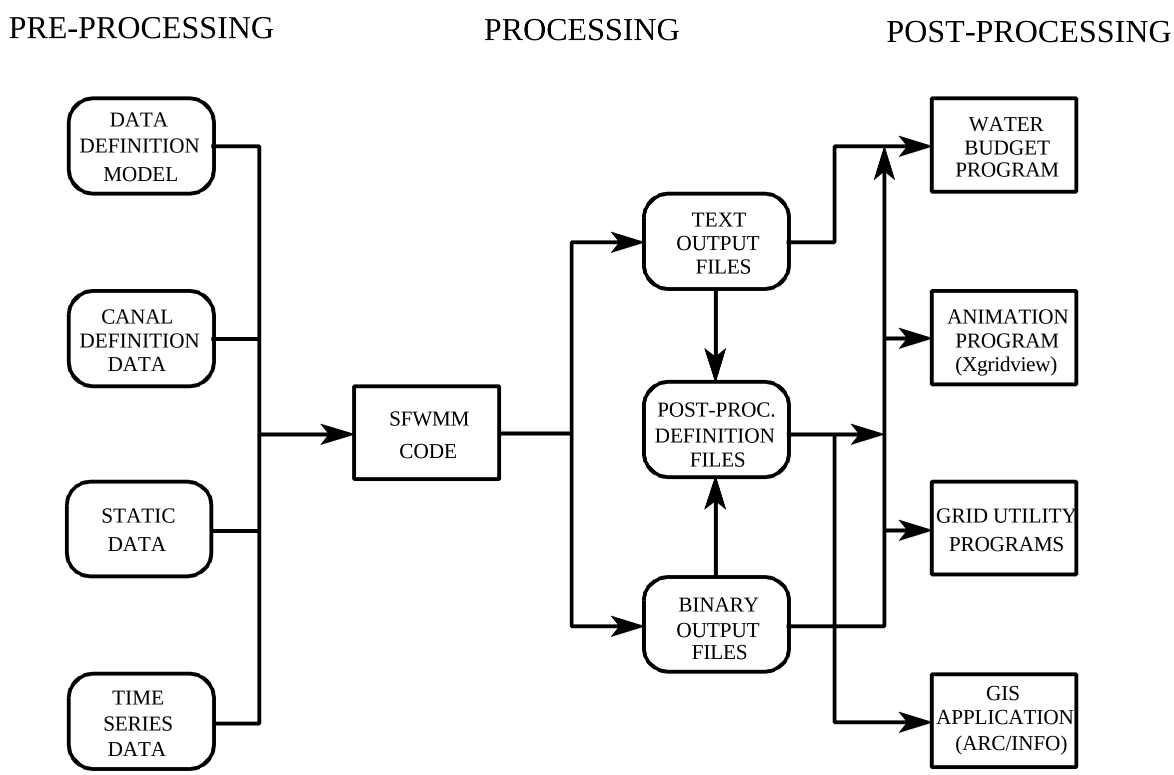


Figure 1.3.4 The South Florida Water Management Modeling System

Figure 1.3.4 illustrates how SFWMM relates to a variety of support utilities (pre- and post-processors). Due to the enormous amounts of input required and output generated by the model, an entire suite of utility program have been developed. A substantial increase in efficiency in evaluating modeling scenarios is realized by using these programs. The interaction between data and computer programs shows that the model should not be considered only as a single computer program but as an entire modeling system or package.

One of the most effective ways of summarizing model output is by way of water budgets. A water budget is an accounting of all components of the hydrologic cycle within a bounded region. In the SFWMM, a water budget provides a quantitative breakdown of these components across the boundaries of areas in South Florida idealized as series of horizontal and vertical segments separating 2-mile by 2-mile grid cells. Figure 1.3.5 shows the major geographical areas where water budget summaries are produced by the water budget program. Knowledge of water budgets for different subregions within the model enables one to make relative comparisons of the quantity and distribution of water within the entire modeling domain.

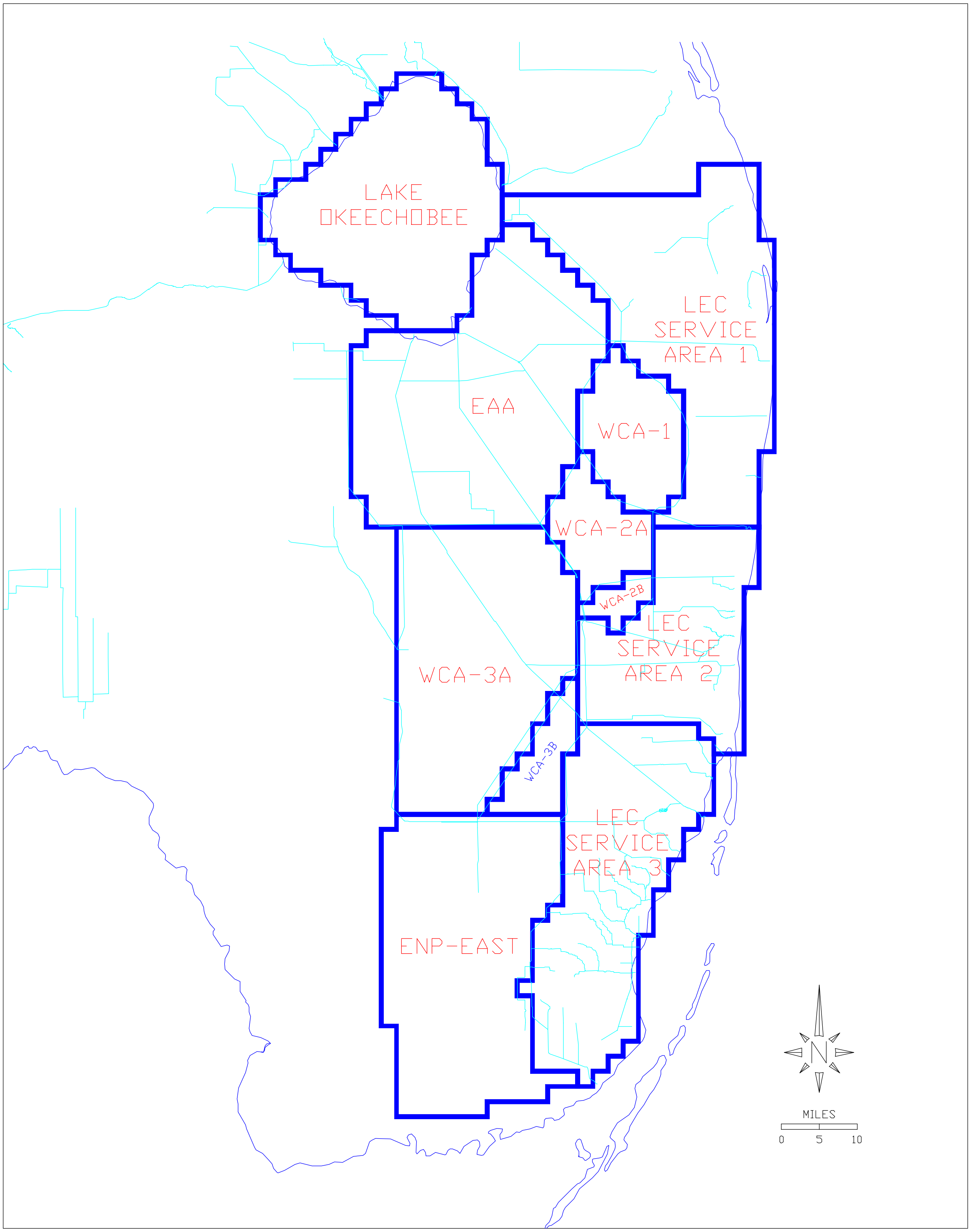


Figure 1.3.5 Major Geographical Areas within the South Florida Water Management Model where Standard Water Budget Summaries are Written During Post-Processing of Model Output